MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

TIC2151 THEORY OF COMPUTATION

(All sections / Groups)

15 OCTOBER 2019
9.00 am – 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 3 pages only excluding the cover page.
2. Attempt all questions. The distribution of the marks for each question is given.
3. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

QUESTION (1)

NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).

(A)

1. What is *regular* language? [2 marks]

2. Prove the following by Construction: [3 marks]

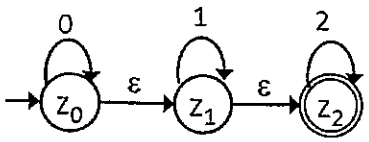
"If a and b are consecutive integers, then the sum $a + b$ is odd."

(B) Draw state diagrams for DFAs accepting the following languages:

L_1= {w ∈ {a, b, c}* | w starts with b and contains at least two occurrences of c. [2.5 marks]

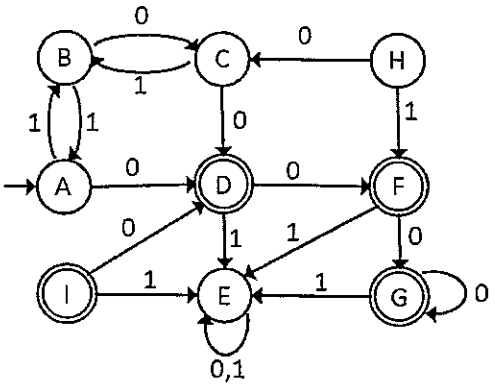
L_2= {w ∈ {a, b, c}*| w contains the substring cba} [2.5 marks]

(C) Convert the following NFA into an NFA without ε-transitions. Show the transition table and the corresponding state diagram. [5 marks]



(D)

Minimize the following DFA. Show your steps. [5 marks]



QUESTION (2)

(A)

1. Determine the language corresponding to each of the following regular expressions:
   i. $0^*10^*10^* + 0^*10^*10^*10^*$ [1.5 marks]
   ii. $aa\,(a + b)^*\,bbb\,(a + b)^*$ [1.5 marks]

2. Find regular expressions corresponding to each of the following languages.
   i. $L = \{ w \in \{0, 1\}^* |$ w not ending with 00 or 11$\}$ [1.5 marks]
   ii. $L = \{ w \in \{0, 1\}^* |$ the length of w is multiple of 3$\}$ [1.5 marks]

(B) Convert the following regular expression into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible. [4 marks]

$$(0 + 1)^*11 + 010$$

(C)

1. Convert the following regular grammar into an NFA. [2 marks]

$A \rightarrow aB \mid bA$
$B \rightarrow aC$
$C \rightarrow bE \mid aD$
$E \rightarrow B \mid \varepsilon$
$D \rightarrow aD \mid bb$

2. Give the regular grammars corresponding to each of the following languages over the alphabet {a, b}.

$L_1 = \{ w \in \{a, b\}^* \mid$ w starts with *a* and ends with *bb* or starts with *aa* and ends with *b*$\}$ [1.5 marks]
$L_2 = (ba)^* + bab^*$ [1.5 marks]

Continue...

QUESTION (3)

(A) Construct a PDA over the alphabet {a, b, c} for each of the following languages:

$L_1 = \{a^{n+m+1} b^m c^n b \mid n, m \geq 1\}$ [3 marks]

$L_2 = \{c\, a^n b^{n+m} a^m \mid n,m \geq 1\}$ [3 marks]

(B) Give the context-free grammars for each of the following languages

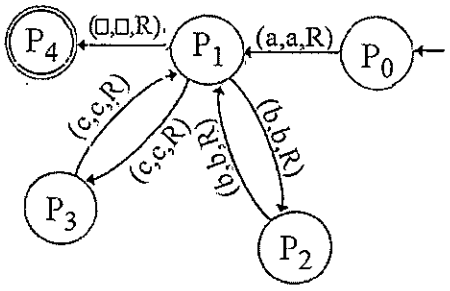
$L_1 = w \in \{a, b\}^* \mid$ w contains exactly three a's or three b's. [2 marks]

$L_2 = \{a^{3n} b^n \mid n \geq 1\}$. [2 marks]

QUESTION (4)

NOTE: Attempt any TWO out of THREE Parts (A), (B) and (C).

(A) Given the following Turing Machine:



1. What language does the machine accept? Give the language in regular expression form. [1 mark]
2. Give the formal definition of the machine including the transition table. [4 marks]

(B) Construct a Turing Machine for the language $L = \{a^n b^n c^m \mid m,n \geq 1\}$. [5 marks]

(C) Prove that the language A is Turing-decidable exactly when both A and its complement $\bar{A}$ are Turing-recognizable. [5 marks]

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